

JCTVC-T0140: Enhanced QP offset signaling for adaptive cross-component transform in SCC extensions

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Summary

■ Enhanced QP signaling is proposed for Adaptive Cross-component Transform (ACT).

- Additional signaling of PPS/Slice-level QP offset values;
- Switching of QP offset values.

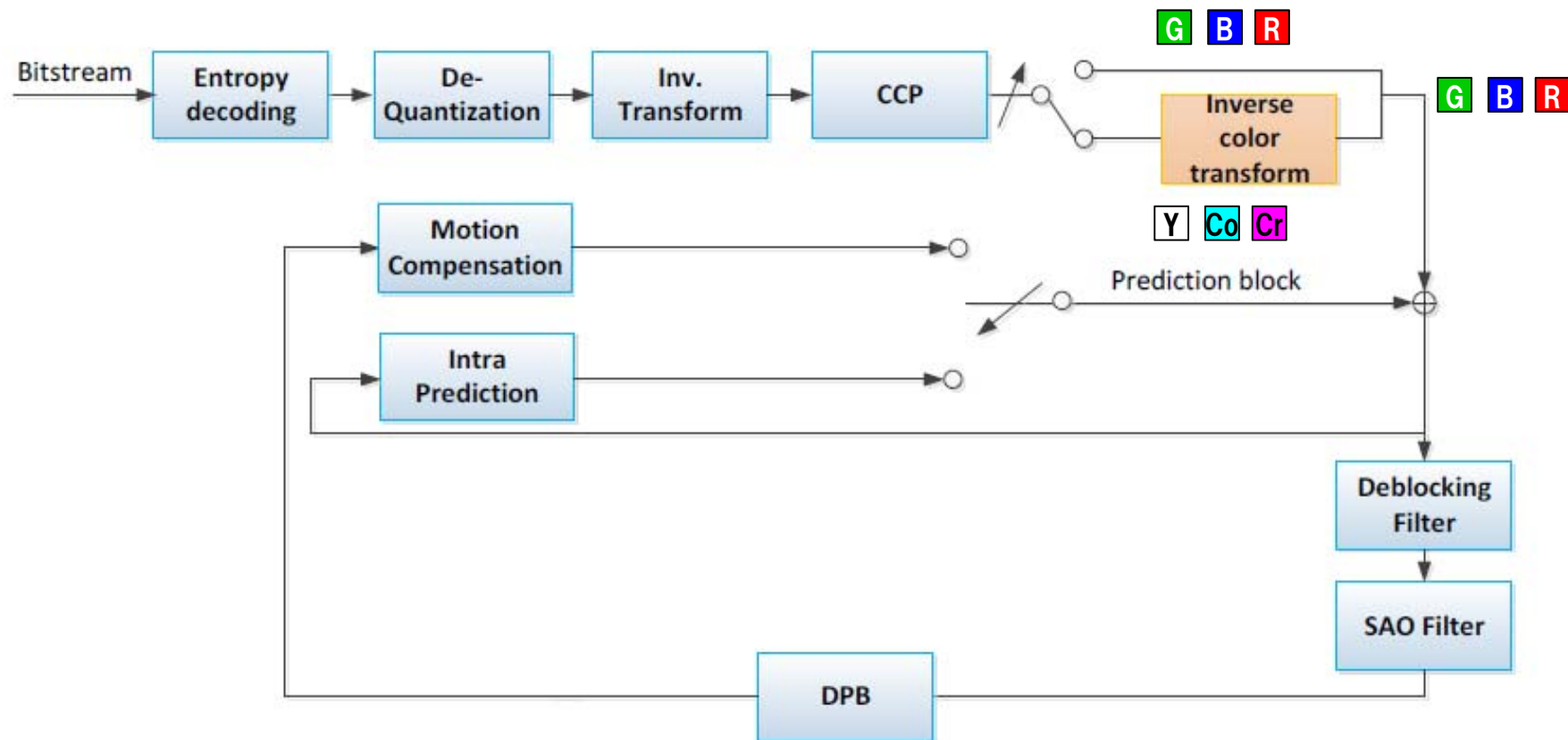
■ Simulation results shows:

- No impact in CTC
- Good gains in non CTC, in which the fidelity of G component is improved by using negative qp value in the region coded by using YCoCr color space.

■ It is recommended that proposal is adopted in the SCC extensions or studied in AHG toward the next meeting.

Background: Adaptive cross-component transform

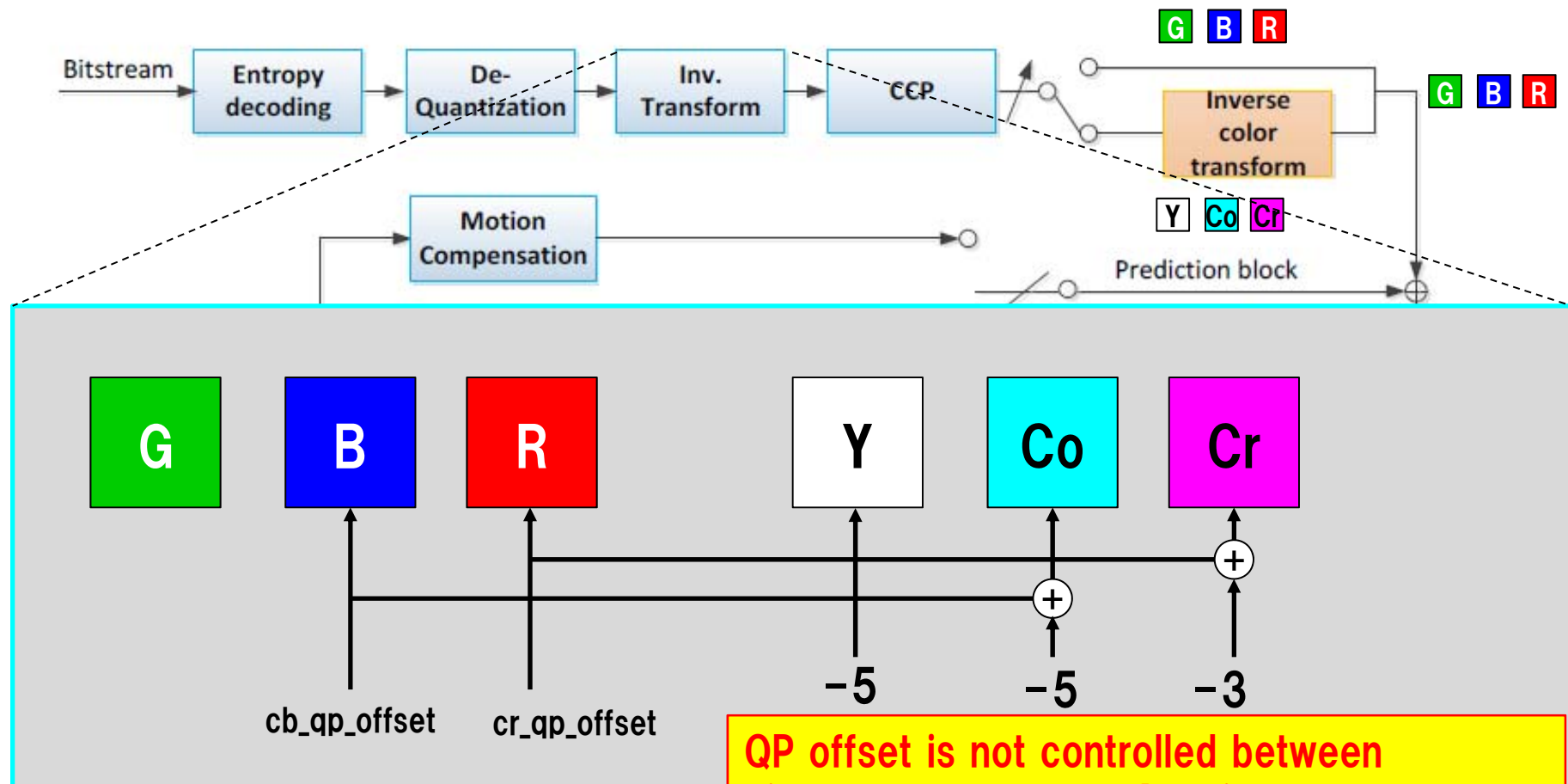
Prediction residual is adaptively represented either in RGB color space or YCoCr color space at CU level.



This figure is from JCTVC-R0147

Problem statement

Same chroma QP offsets values are applied to RGB prediction residual and YCoCr prediction residual.

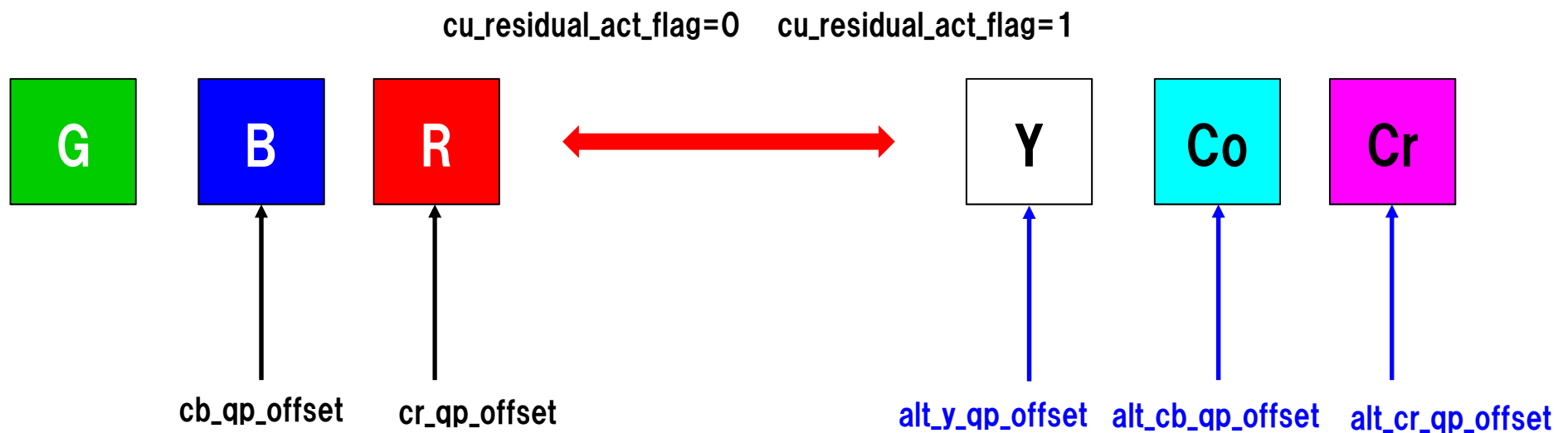


QP offset is not controlled between different color spaces! This problem was reported in the previous meeting.

Proposal on top of previous contributions JCTVC-S0040, JCTVC-S0094, JCTVC-S0144, and JCTVC-S0300

■ Use different QP offset values for different color-space prediction residues when ACT is enabled.

- Additional PPS/Slice-level QP offset signaling for ACT;
- QP offset switching based on ACT flag.



QP offset is controlled between different color spaces!

Detail of proposal (1/3)

PPS-level QP offset signaling

pps_scc_extension () {	Descriptor
residual_adaptive_colour_transform_enabled_flag	u(1)
if(residual_adaptive_colour_transform_enabled_flag){	
pps_slice_act_qp_offsets_present_flag	u(1)
pps_act_y_qp_offset_plus5	se(v)
pps_act_cb_qp_offset_plus5	se(v)
pps_act_cr_qp_offset_plus3	se(v)
}	
}	

Detail of proposal (2/3)

Slice-level QP offset signaling

slice_segment_header() {	Descriptor
first_slice_segment_in_pic_flag	u(1)
.....	
slice_qp_delta	se(v)
if(pps_slice_chroma_qp_offsets_present_flag) {	
slice_cb_qp_offset	se(v)
slice_cr_qp_offset	se(v)
}	
if(chroma_qp_offset_list_enabled_flag)	
cu_chroma_qp_offset_enabled_flag	u(1)
if(pps_slice_act_qp_offsets_present_flag){	
slice_act_y_qp_offset	se(v)
slice_act_cb_qp_offset	se(v)
slice_act_cr_qp_offset	se(v)
}	
.....	

Detail of proposal (3/3)

QP switching

[In the derivation process for quantization parameters (Section 8.6.1):]

When ChromaArrayType is not equal to 0, the following applies.

- If $\text{cu_residual_act_flag}[\text{xTbY}][\text{yTbY}]$ is equal to 0, the variables qP_{Cb} and qP_{Cr} are derived as follows:

$$qP_{Cb} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_cb_qp_offset + slice_cb_qp_offset + CuQpOffset_{Cb})$$

$$qP_{Cr} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_cr_qp_offset + slice_cr_qp_offset + CuQpOffset_{Cr})$$

- Otherwise ($\text{cu_residual_act_flag}[\text{xTbY}][\text{yTbY}]$ is equal to 1), the variables qP_{Cb} and qP_{Cr} are derived as follows:

$$qP_{Cb} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_act_cb_qp_offset + slice_act_cb_qp_offset + CuQpOffset_{Cb})$$

$$qP_{Cr} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_act_cr_qp_offset + slice_act_cr_qp_offset + CuQpOffset_{Cr})$$

[In the scaling and transformation process (Section 8.6.2)]

The quantization parameter qP is derived as follows:

- If $cIdx$ is equal to 0,

$$qP = \text{Clip3}(0, 51 + QpBdOffset_Y, Qp'_Y + (\text{cu_residual_act_flag}[\text{xTbY}][\text{yTbY}] ? pps_act_y_qp_offset + slice_act_y_qp_offset : 0))$$

$$qP = \max(0, Qp'_Y + (\text{cu_residual_act_flag}[\text{xTbY}][\text{yTbY}] ? -5 : 0))$$

- Otherwise, if $cIdx$ is equal to 1,

$$qP = \max(0, Qp'_{Cb} + (\text{cu_residual_act_flag}[\text{xTbY}][\text{yTbY}] ? -5 : 0))$$

- Otherwise ($cIdx$ is equal to 2),

$$qP = \max(0, Qp'_{Cr} + (\text{cu_residual_act_flag}[\text{xTbY}][\text{yTbY}] ? -3 : 0))$$

Simulation

■ Test1: Common test condition (QP offset value of 0)

- Reference: SCM-3.0 with --CbQpOffset=0 --CrQpOffset=0
- Tested: Proposal with --CbQpOffset=0 --CrQpOffset=0
--ActQpYOffset=-5 --ActQpCbOffset=-5 --ActQpCrOffset=-3

■ Test2: Not common test condition using QP offset value of -6

- Reference: SCM-3.0 with --CbQpOffset=-6 --CrQpOffset=-6
- Tested: Proposal with --CbQpOffset=0 --CrQpOffset=0
--ActQpYOffset=-5 --ActQpCbOffset=-11 --ActQpCrOffset=-9

It is intended that the fidelity of G component is improved by using the negative qp value only in the region coded by using YCoCr color space.

Test1 results: Common test condition

No impact on R-D results.

	All Intra		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	100%		
Dec Time[%]	101%		

	Random Access		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	100%		
Dec Time[%]	99%		

	Low delay B		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	100%		
Dec Time[%]	100%		

Test2 results: Not common test condition

Proposal shows gains in G component since it does not spend too much bits in B and R information of the regions coded by using RGB color space.

	All Intra		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-10.3%	2.4%	2.6%
RGB, mixed content, 1440p & 1080p	-9.8%	4.8%	5.4%
RGB, Animation, 720p	-12.9%	10.7%	9.0%
RGB, camera captured, 1080p	-37.9%	9.7%	2.9%
YUV, text & graphics with motion, 1080p & 720p	NA	NA	NA
YUV, mixed content, 1440p & 1080p	NA	NA	NA
YUV, Animation, 720p	NA	NA	NA
YUV, camera captured, 1080p	NA	NA	NA
Enc Time[%]	97%		
Dec Time[%]	97%		

	Random Access		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-12.8%	4.1%	4.2%
RGB, mixed content, 1440p & 1080p	-20.2%	5.1%	5.6%
RGB, Animation, 720p	-19.8%	9.0%	8.9%
RGB, camera captured, 1080p	-37.0%	7.0%	-3.4%
YUV, text & graphics with motion, 1080p & 720p	NA	NA	NA
YUV, mixed content, 1440p & 1080p	NA	NA	NA
YUV, Animation, 720p	NA	NA	NA
YUV, camera captured, 1080p	NA	NA	NA
Enc Time[%]	95%		
Dec Time[%]	97%		

	Low delay B		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-11.8%	6.3%	6.1%
RGB, mixed content, 1440p & 1080p	-21.1%	8.2%	8.8%
RGB, Animation, 720p	-24.3%	16.3%	17.4%
RGB, camera captured, 1080p	-43.0%	13.7%	1.8%
YUV, text & graphics with motion, 1080p & 720p	NA	NA	NA
YUV, mixed content, 1440p & 1080p	NA	NA	NA
YUV, Animation, 720p	NA	NA	NA
YUV, camera captured, 1080p	NA	NA	NA
Enc Time[%]	95%		
Dec Time[%]	97%		

Conclusion and recommendation

- Enhanced QP offset signaling for ACT is proposed.**
 - Additional signaling of PPS/Slice-level QP offset values;
 - Switching of QP offset values.

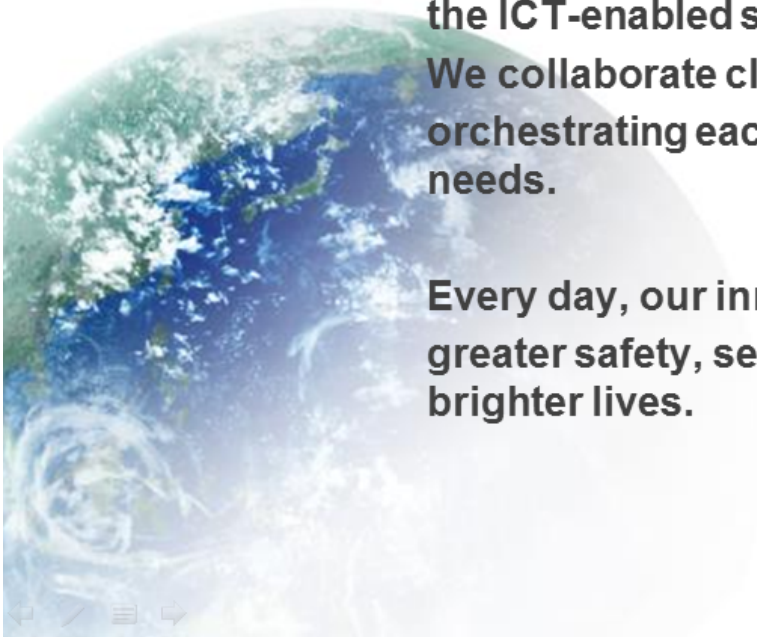
- Proposal is adopted in the SCC extensions or studied in AHG toward the next meeting.**

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